CLAIMS

I/We claim:

[c1] 1. A microelectronic imager, comprising:

an imaging unit including (a) a microelectronic die with an image sensor and a plurality of external contacts electrically coupled to the image sensor, and (b) a first referencing element fixed to the imaging unit; and

an optics unit having an optic member and a second referencing element fixed to the optics unit, the second referencing element being seated with the first referencing element at a fixed, preset position in which the optic member is situated at a desired location relative to the image sensor.

[c2] 2. The imager of claim 1 wherein:

the first referencing element has a first interface feature at a first reference location relative to the image sensor on the die;

the second referencing element has a second interface feature at a second reference location relative to the optic member; and

the first interface feature is engaged with the second interface feature with the first reference location coinciding with the second reference location whereby the optic member is aligned with the image sensor and positioned at a desired distance from the image sensor.

[c3] 3. The imager of claim 1 wherein:

the first referencing element comprises a first support projecting from the die, the first support having a first alignment component at a preset lateral location from the image sensor and a first stop component at a fixed, preset elevation from the image sensor; and

the second referencing element comprises a second support fixed to the optics unit, the second support having (a) a second alignment component juxtaposed to the first alignment component to align the optic member with a centerline of the image sensor, and (b) a second stop component juxtaposed to the first stop component to space the optic member apart from the image sensor by a desired distance.

[c4] 4. The imager of claim 1 wherein:

the imaging unit further comprises a cover over the die;

the first referencing element comprises a first support projecting from the cover, the first support having a first alignment component at a preset lateral location from the image sensor and a first stop component at a fixed, preset elevation from the image sensor; and

the second referencing element comprises a second support projecting from the optics unit, the second support having (a) a second alignment component juxtaposed to the first alignment component to align the optic member with a centerline of the image sensor, and (b) a second stop component juxtaposed to the first stop component to space the optic member apart from the image sensor by a desired distance.

[c5] 5. The imager of claim 1 wherein the first referencing element comprises a first support on the die around the image sensor and the second referencing element comprises a second support on the optics unit around the

optic member, and the first support on the die is mated with the second support on the optics unit.

[c6] 6. The imager of claim 1 wherein:

the imaging unit further comprises a cover over the image sensor; and

the first referencing element comprises a first support on the cover and the second referencing element comprises a second support on the optics unit around the optic member, and the first support on the cover is mated with the second support on the optics unit.

[c7] 7. The imager of claim 1 wherein the first referencing element comprises a first support having a first step and the second referencing element comprises a second support having a second step mated with the first step of the first support.

[c8] 8. The imager of claim 1 wherein one of the first or second referencing elements comprises a channel and the other of the first or second referencing elements comprises a projection received in the channel.

[c9] 9. The imager of claim 1 wherein:

the imaging unit further comprises a cover over the image sensor;

the first referencing element comprises a depression in the cover; and

the second referencing element comprises a support having a distal protrusion received in the depression in the cover.

[c10] 10. The imager of claim 1 wherein:

the imaging unit further comprises a cover over the image sensor;

the optics unit further comprises a substrate carrying the optic member;

the first referencing element comprises a support projecting from the cover and having a distal protrusion; and

the second referencing element comprises a depression in the substrate, and the distal protrusion of the support being received in the depression.

[c11] 11. The imager of claim 1 wherein the first referencing element comprises a plurality of guides projecting from one of the die or a cover over the die, and the second referencing element comprises a support extending from the optics unit that has bearing surfaces juxtaposed with the guides.

[c12] 12. The imager of claim 1 wherein the first referencing element comprises a first support projecting from one of the die or a cover over the die and a first radial alignment component at the support, and the second referencing element comprises a second support projecting from the optics unit and a second radial alignment component at the second support, and wherein the first and second radial alignment components are aligned to radially align the optic member with the image sensor.

[c13] 13. The imager of claim 1 wherein the first referencing element comprises a first support projecting from one of the die or a cover over the die and the second referencing element comprises a second support projecting from the optics unit, the first support having a first inclined surface, and the second support having a complementary inclined surface engaging the first inclined surface.

[c14] 14. A microelectronic imager, comprising:

a microelectronic die having an image sensor and a plurality of contacts electrically coupled to the image sensor;

a first referencing element fixed relative to the die, the first referencing element having a first alignment component at a lateral distance from the image sensor and a first stop component spaced apart from the image sensor along an axis normal to the image sensor by separation distance;

an optics unit having an optic member; and

a second referencing element connected to the optics unit, the second referencing element having a second alignment component engaged with the first alignment component to align the optic member with the image sensor and a second stop component engaged with the first stop component to space the optic member apart from the image sensor by a desired distance.

[c15] 15. The imager of claim 14 wherein:

the first referencing element comprises a first support projecting from one of the die or a cover over the die, and the first support includes the first alignment component and the first stop component; and

the second referencing element comprises a second support projecting from the optics unit, and the second support includes the second alignment component and the second stop component.

[c16] 16. The imager of claim 14 wherein the first referencing element comprises a first support having a first step and the second referencing element comprises a second support having a second step mated with the first step of the first support.

[c17] 17. The imager of claim 14 wherein one of the first or second referencing elements comprises a channel and the other of the first or second referencing elements comprises a projection received in the channel.

[c18] 18. A microelectronic imager, comprising:

an imaging unit including (a) a microelectronic die having an image sensor and a plurality of external contacts electrically connected to the image sensor, and (b) a first referencing element fixed to the imaging unit; and

an optics unit including an optic member and a second referencing element fixed to the optics unit and seated with the first referencing element, the first and second referencing elements being configured to align the optic member with the image sensor and space the optic member apart from the image sensor by a desired distance when the first and second referencing elements are seated together.

[c19] 19. The imager of claim 18 wherein:

the first referencing element has a first interface feature at a first reference location relative to the image sensor on the die;

the second referencing element has a second interface feature at a second reference location relative to the optic member; and

the first interface feature is engaged with the second interface feature with the first reference location coinciding with the second reference location whereby the optic member is aligned with the image sensor and positioned at a desired distance from the image sensor.

[c20] 20. The imager of claim 18 wherein:

the first referencing element comprises a first support projecting from the die, the first support having a first alignment component at a preset lateral location from the image sensor and a first stop component at a fixed, preset elevation from the image sensor; and

the second referencing element comprises a second support fixed to the optics unit, the second support having (a) a second alignment component juxtaposed to the first alignment component to align the optic member with a centerline of the image sensor, and (b) a second stop component juxtaposed to the first stop component to space the optic member apart from the image sensor by a desired distance.

[c21] 21. The imager of claim 18 wherein:

the imaging unit further comprises a cover over the die;

the first referencing element comprises a first support projecting from the cover, the first support having a first alignment component at a preset lateral location from the image sensor and a first stop component at a fixed, preset elevation from the image sensor; and

the second referencing element comprises a second support projecting from the optics unit, the second support having (a) a second alignment component juxtaposed to the first alignment component to align the optic member with a centerline of the image sensor, and (b) a second stop component juxtaposed to the first stop component to space the optic member apart from the image sensor by a desired distance.

[c22] 22. The imager of claim 18 wherein the first referencing element comprises a first support on the die around the image sensor and the second referencing element comprises a second support on the optics unit around the optic member, and the first support on the die is mated with the second support on the optics unit.

[c23] 23. The imager of claim 18 wherein:

the imaging unit further comprises a cover over the die; and

the first referencing element comprises a first support on the cover and the second referencing element comprises a second support on the optics unit around the optic member, and the first support on the cover is mated with the second support on the optics unit.

[c24] 24. The imager of claim 18 wherein the first referencing element comprises a first support having a first step and the second referencing element comprises a second support having a second step mated with the first step of the first support.

[c25] 25. The imager of claim 18 wherein the first referencing element comprises a first support projecting from one of the die or a cover over the die and the second referencing element comprises a second support projecting from the optics unit, the first support having a first inclined surface, and the second support having a complementary inclined surface engaging the first inclined surface.

[c26] 26. A microelectronic imager, comprising:

an imaging unit including (a) a microelectronic die with an image sensor and a plurality of external contacts electrically coupled to the image sensor, and (b) a first stand-off section fixed to the imaging unit and having a first interface area at a set reference position relative to the image sensor; and

an optics unit having an optic member and a second stand-off section fixed to the optics unit, the second stand-off section having a second interface area at a set reference position relative to the optic member, and the first interface area being seated with the second interface area to connect the first stand-off section with the second stand-off section in a configuration in which the optic member is at a desired location relative to the image sensor.

[c27] 27. The imager of claim 26 wherein:

the first stand-off section projects from the die, and the first interface area has a first alignment component at a preset lateral location from the image sensor and a first stop component at a fixed, preset elevation from the image sensor; and

the second stand-off section projects from the optics unit, and the second interface area has (a) a second alignment component juxtaposed to the first alignment component to align the optic member with a centerline of the image sensor, and (b) a second stop component juxtaposed to the first stop component to space the optic member apart from the image sensor by a desired distance.

[c28] 28. The imager of claim 26 wherein:

the imaging unit further comprises a cover over the die;

the first stand-off section projects from the cover, and the first interface area has a first alignment component at a preset lateral location from the image sensor and a first stop component at a fixed, preset elevation from the image sensor; and

the second stand-off section projects from the optics unit, and the second interface area has (a) a second alignment component juxtaposed to the first alignment component to align the optic member with a centerline of the image sensor, and (b) a second stop component juxtaposed to the first stop component to space the optic member apart from the image sensor by a desired distance.

[c29] 29. The imager of claim 26 wherein the first stand-off section projects from the die and extends around the image sensor and the second stand-off section projects from the optics unit extends around the optic member, and the first interface area is mated with the second interface area.

[c30] 30. The imager of claim 26 wherein:

the image sensor further comprises a cover over the image sensor; and

the first stand-off section projects from the cover and the second stand-off section projects from the optics unit, and the first interface area is mated with the second interface area.

[c31] 31. The imager of claim 26 wherein the first interface area comprises a first step and the second interface area comprises a second step mated with the first step.

[c32] 32. The imager of claim 26 wherein one of the first or second stand-off sections includes a channel and the other of the first or second stand-off sections includes a projection received in the channel.

[c33] 33. The imager of claim 26 wherein the first stand-off section comprises a plurality of guides projecting from one of the die or a cover over the die, and the second stand-off section comprises a support extending from the optics unit that has bearing surfaces juxtaposed with the guides.

[c34] 34. The imager of claim 26 wherein the first stand-off section comprises a first support projecting from one of the die or a cover over the die and a first radial alignment component at the support, and the second stand-off section comprises a second support projecting from the optics unit and a second radial alignment component at the second support, and wherein the first and second radial alignment components are aligned to radially align the optic member with the image sensor.

[c35] 35. The imager of claim 26 wherein the first stand-off section projects from one of the die or a cover over the die and the second stand-off section projects from the optics unit, and the first interface area has a first inclined surface, and the second interface area has a complementary inclined surface engaging the first inclined surface.

[c36] 36. A microelectronic workpiece, comprising:

a substrate;

a plurality of individual dies on the substrate, wherein individual dies include an image sensor and external electrical contacts electrically coupled to the image sensor; and

a plurality of discrete referencing elements on the substrate positioned at corresponding dies, wherein individual referencing elements have an alignment component at a predetermined lateral distance from a corresponding image sensor and a stop component at a predetermined elevation with respect to a corresponding image sensor to position an optic member at a desired location relative to the image sensor.

[c37] 37. A workpiece of optics units for imagers, comprising:

a substrate;

a plurality of individual optics units on the substrate, wherein individual optics units include an optic member; and

a plurality of discrete referencing elements on the substrate positioned at corresponding optic members, wherein individual referencing elements have an alignment component at a predetermined lateral distance from a corresponding optic member and a stop component at a predetermined elevation with respect to a corresponding optic member to position the optic member at a desired location relative to an image sensor of an imager.

[c38] 38. An assembly of a plurality of imagers, comprising:

a microelectronic workpiece comprising a first substrate, a plurality of dies on the first substrate, and a plurality of first referencing elements on the first substrate, wherein individual dies have an image sensor and external electrical contacts electrically coupled to the image sensor, and wherein individual first referencing elements are positioned at a predetermined location relative to a corresponding image sensor of a corresponding die; and

an optics workpiece comprising a second substrate, a plurality of optics units on the second substrate, and a plurality of second referencing elements on the second substrate, wherein individual optics units have an optic member and individual second referencing elements are positioned at a predetermined location relative to a corresponding optic member, and wherein the second referencing elements are seated with corresponding first referencing elements at fixed, predetermined positions relative to corresponding image sensors in which individual optic members are situated at a desired location relative to corresponding individual image sensors.

[c39] 39. A method of packaging an imager, comprising:

providing an imaging unit having (a) a microelectronic die with an image sensor and a plurality of external contacts electrically coupled to the image sensor, and (b) a first referencing element fixed to the imaging unit and having a first interface feature at a set reference position relative to the image sensor;

providing an optics unit having an optic member and a second referencing element fixed to the optics unit, the second referencing element having a second interface feature at a set reference position relative to the optic member; and

attaching the second referencing element to the first referencing element by seating the second interface feature with the first interface feature in a predetermined position in which the optic member is at a desired location relative to the image sensor.

[c40] 40. The method of claim 39 wherein attaching the second referencing element to the first referencing element comprises moving at least one of the imaging unit and the optics unit toward the other using automated equipment.

[c41] 41. The method of claim 39 wherein the imaging unit is a first imaging unit of a plurality of imaging units on a microelectronic workpiece, and wherein providing the imaging unit comprises constructing the first referencing element on the workpiece at the first imaging unit before separating the first imaging unit from the workpiece.

[c42] 42. The method of claim 39 wherein the first referencing element comprises a first support around the image sensor and the second referencing element comprises a second support on the optics unit around the optic member, and wherein attaching the first referencing element to the second referencing element comprises mating the first support with the second support.

[c43] 43. The method of claim 39 wherein the first referencing element comprises a first support having a first step and the second referencing element comprises a second support having a second step, and wherein attaching the first referencing element to the second referencing element comprises mating the first step of the first support with the second step of the second support.

[c44] 44. The method of claim 39 wherein one of the first or second referencing elements comprises a channel and the other of the first or second referencing elements comprises a projection received in the channel, and wherein attaching the first referencing element to the second referencing element comprises inserting the protrusion into the channel.

[c45] 45. The method of claim 39 wherein:

the imaging unit further comprises a cover over the image sensor, the first referencing element comprises a depression in the cover, and the second referencing element comprises a support having a distal protrusion; and

attaching the first referencing element to the second referencing element comprises inserting the protrusion into the depression.

[c46] 46. The method of claim 39 wherein:

the imaging unit further comprises a cover over the image sensor, the optics unit further comprises a substrate carrying the optic member, the first referencing element comprises a support having a distal protrusion, and the second referencing element comprises a depression in the substrate; and

attaching the first referencing element to the second referencing element comprises inserting the protrusion into the depression.

[c47] 47. The method of claim 39 wherein the first referencing element comprises a plurality of guides projecting from one of the die or a cover over the

die, and the second referencing element comprises a support extending from the optics unit that has bearing surfaces, and wherein attaching the first referencing element to the second referencing element comprises positioning the bearing surfaces next to the guides.

[c48] 48. The method of claim 39 wherein the first referencing element comprises a first support projecting from one of the die or a cover over the die and a first radial alignment component at the support, and the second referencing element comprises a second support projecting from the optics unit and a second radial alignment component at the second support, and wherein attaching the first referencing element to the second referencing element comprises aligning the first radial alignment component with the second radial alignment component to radially align the optic member with the image sensor.

[c49] 49. The method of claim 39 wherein the first referencing element comprises a first support projecting from one of the die or a cover over the die and the second referencing element comprises a second support projecting from the optics unit, the first support having a first inclined surface, and the second support having a complementary inclined surface, and wherein attaching the first referencing element to the second referencing element comprises engaging the first inclined surface with the second inclined surface.

[c50] 50. A method of packaging an imager, comprising:

providing a plurality of imaging units on a microelectronic workpiece, wherein individual imaging units include (a) a microelectronic die with an image sensor and a plurality of external contacts electrically coupled to the image sensor, and (b) a first referencing element fixed to the workpiece;

providing a plurality of optics units on an optic workpiece, wherein individual optics units include an optic member and a second referencing element fixed to the optics unit; and

attaching the first referencing element of individual imaging units to corresponding second referencing elements of corresponding optics units.

[c51] 51. The method of claim 50, further comprising singulating the imaging units from each other and testing the imaging units to determine known-good-units, and wherein the attaching procedure comprises attaching the first referencing elements of known-good-units to corresponding second referencing elements of corresponding optics units.

[c52] 52. The method of claim 51 wherein attaching the first referencing elements of known-good-units to corresponding second referencing elements of corresponding optics units occurs before singulating the optics workpiece.

[c53] 53. The method of claim 51 wherein attaching the first referencing elements of known-good-units to corresponding second referencing elements of corresponding optics units occurs after singulating the optics workpiece.

[c54] 54. The method of claim 50, further comprising singulating the optics workpiece to separate the individual optics units, and wherein the attaching procedure comprises attaching the second referencing elements of separated optics units to corresponding first referencing elements of corresponding imaging units.

[c55] 55. The method of claim 51 wherein the attaching procedure comprises mating the first referencing elements with corresponding second referencing element before singulating either the microelectronic workpiece or the optics workpiece.

[c56] 56. The method of claim 51 wherein providing the imaging units comprises constructing the first referencing elements on the microelectronic workpiece using stereolithography processing.

[c57] 57. The method of claim 51 wherein providing the optics units comprises constructing the second referencing elements on the optics workpiece using stereolithography processing.